

Substation Design Instruction

Plugboard 12/24kV switchgear

IMPORTANT DISCLAIMER

As the information contained in this publication is subject to change from time to time, Endeavour Energy gives no warranty that the information is correct or complete or is a definitive statement of procedures. Endeavour Energy reserves the right to vary the content of this publication as and when required. You should make independent inquiries to satisfy yourself as to correctness and currency of the content. Endeavour Energy expressly disclaims all and any liability to any persons whatsoever in respect of anything done or not done by any such person in reliance, whether in whole or in part, on this document.

Document no. SDI 208

Amendment no. 5

Copyright © Endeavour Energy 2016

SUBSTATION DESIGN INSTRUCTION

ASSET STANDARDS & DESIGN	Document No.	SDI 208
	Amendment No.	5
	Approved By	MASD
	Approval Date	23/03/16
	Review Date	23/03/19

SDI 208 Plugboard 12/24kV switchgear

Contents

1.0	PURPOSE	3
2.0	SCOPE	3
3.0	REFERENCES	3
4.0	DEFINITIONS AND ABBREVIATIONS	3
5.0	ACTIONS	3
5.1	General	3
5.2	Electrical specification	4
5.2.1	<i>Insulation level (all equipment)</i>	4
5.2.2	<i>Cable branch connectors (bolted connection)</i>	4
5.2.3	<i>Bushings</i>	4
5.2.4	<i>Fuse carrier</i>	4
5.3	Dimensions	4
5.3.1	<i>Complete unit dimensions</i>	5
5.4	Frame	5
5.4.1	<i>Component parts</i>	6
5.5	Cast epoxy resin bushings	6
5.6	Cable terminating branch connectors (elbows)	7
5.7	Fuse assembly	8
5.8	Transformer connection	8
5.9	Anti-condensation heaters	9
5.10	Accessories	9
5.10.1	<i>Earthing</i>	9
5.10.2	<i>Short circuit indicators</i>	10
5.11	Operating procedure	10
5.11.1	<i>General</i>	10
5.11.2	<i>Fuse assembly</i>	10
5.11.3	<i>Branch connectors (elbows)</i>	11
5.12	Operating single line diagrams	12
5.13	Drawings	12
6.0	AUTHORITIES AND RESPONSIBILITIES	12
7.0	DOCUMENT CONTROL	13

1.0 PURPOSE

To provide details for the application and installation of plugboard 12/24kV switchgear on Endeavour Energy's distribution network.

2.0 SCOPE

This instruction includes the technical requirements for electrical, mechanical and operational parameters, and gives details only for equipment purchased and installed on Endeavour Energy's network.

Note: This switchgear is no longer approved for use in new installations on Endeavour Energy's network. This instruction is for reference purposes only.

Units removed from the Network are to be disposed of according to Company Procedure GSU 0006.

3.0 REFERENCES

- Company Policy 9.1.7 - Commissioning Network Electrical Assets
- Company Policy 9.2.10 - Network Asset Ratings
- Company Policy 9.2.5 - Network Asset Design
- Company Procedure GSU 0006 - Disposal of surplus goods and equipment
- Earthing Design Instruction EDI 100 - Distribution earthing design, construction and test
- Equipment Technical Specification ETS 0071 - Distribution fuses
- Mains Design Instruction MDI 0028 - Underground distribution network design
- Substation Design Instruction SDI 101 - Distribution substations: general details and minimum requirements
- Endeavour Energy Network Management Plan – December 2013 Review
- AS 1033.2 - High voltage fuses for rated voltages exceeding 1000V – current limiting type
- AS 2650 - Common specifications for high voltage switchgear and controlgear standards
- ENA National Electricity Network Safety Code (Doc. 01-2008)
- NSW Work Health and Safety Act 2011
- NSW Work Health and Safety Regulation 2011

4.0 DEFINITIONS AND ABBREVIATIONS

A full list of definitions is contained in SDI 101.

5.0 ACTIONS

5.1 General

The plugboard is a combination of 1, 2 or 3 feeder, non-load break, branch connectors (elbows), together with a single fuse unit, for supply to a transformer. Any work on this unit, such as connections, disconnections or replacement of fuse, is to be carried out only when **de-energised**.

The plugboard 12/24kV switchgear is indoor switchgear, suitable for use in padmount substations. It consists of three (3) 24kV double end bushings, mounted on a steel frame, with 12/24kV fuse assemblies connected to one side, and up to a maximum of three (3) cables on each phase connected to the other side with branch connectors.

The plugboard was primarily for use in URD areas reticulated at 22kV, however, these are being progressively decommissioned from the network.

All three (3) feeder padmount substations were fitted with plugboards. The plugboard shall not be used in new installations: existing units shall be replaced with an approved suitable ring-main unit when found to be faulty.

The remaining padmount substations are fitted with metal-enclosed ring main units for switching purposes. This strategy was designed to minimise the cost of 22kV reticulation and maintenance, while retaining appropriate operational flexibility.

5.2 Electrical specification

5.2.1 Insulation level (all equipment)

Rated voltage	12kV	24kV
1.2/50 impulse withstand:	95kV	125kV
Power frequency withstand -	28kV	50kV
Rated frequency	50Hz	50Hz

5.2.2 Cable branch connectors (bolted connection)

Rated voltage	12kV	24kV
Rated normal current	400A	400A
Rated one sec. withstand current	13.1kA	13.1kA
Rated peak withstand current	32.8kA	32.8kA

5.2.3 Bushings

Rated voltage	12kV	24kV
Rated normal current	400A	400A
Max. overcurrent capacity (24hr)	480A	480A
Rated one sec. withstand current	17.5kA	17.5kA

5.2.4 Fuse carrier

Rated voltage	12kV	24kV
Rated normal current	200A	200A

Will accommodate current limiting fuse links to AS 1033.2 - fuse link type I.

5.3 Dimensions

Height	1350mm	Weight	100kg
Depth	1000mm		
Width	900mm		

5.3.1 Complete unit dimensions

Branch connectors and cables omitted for clarity

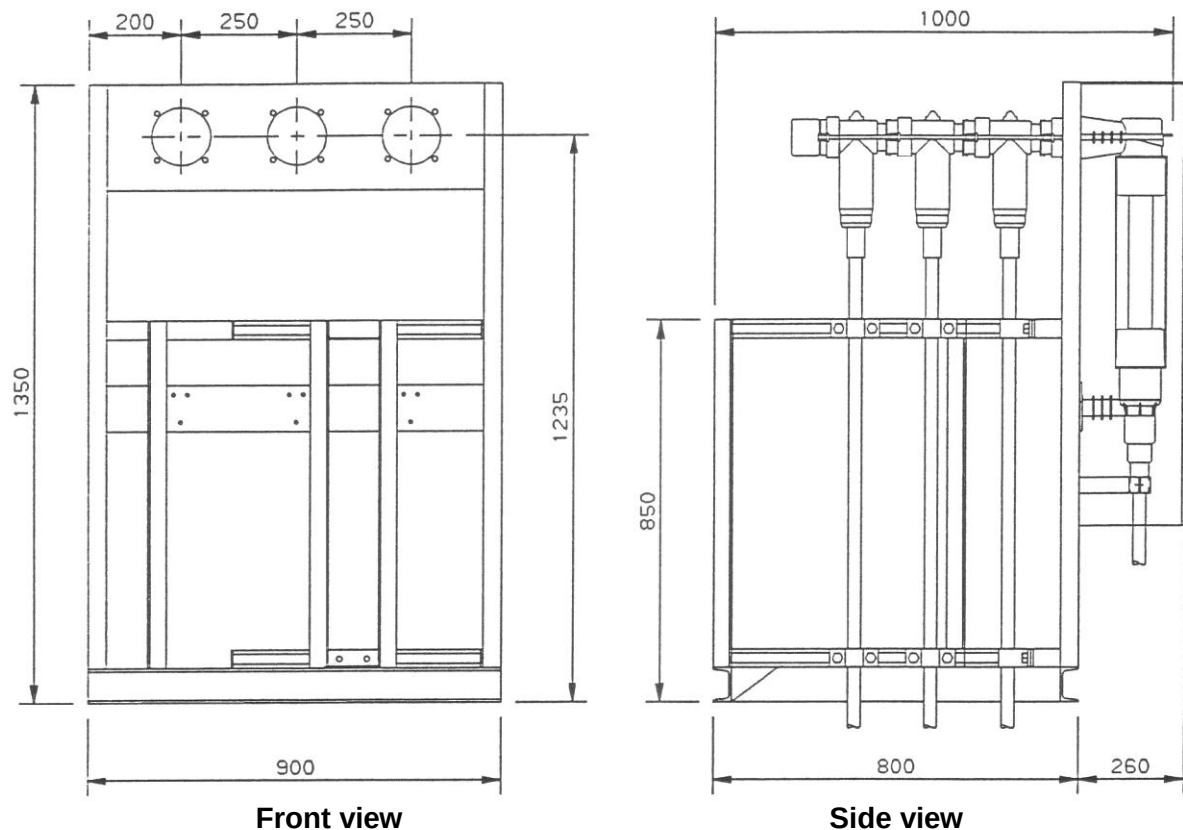


Figure 1 - Plugboard switchgear dimensions

5.4 Frame

The steel frame has been designed to incorporate the following features:

- *Unistrut* channel in the areas where cable support clamps will be located, to provide various clamping positions.
- Removable rear cable support to facilitate cable jointing.
- Holes in the frame for earthing.
- An opening in the *Unistrut* channel allowing the HV cables to be laid through the frame to their respective final clamping positions.
- Phase identification on the front and rear of the frame.

The phase sequence is red, white and blue, from left to right, when the switchgear is viewed from the front.

The frame is manufactured in accordance with Drawing no. 077512.

5.4.1 Component parts

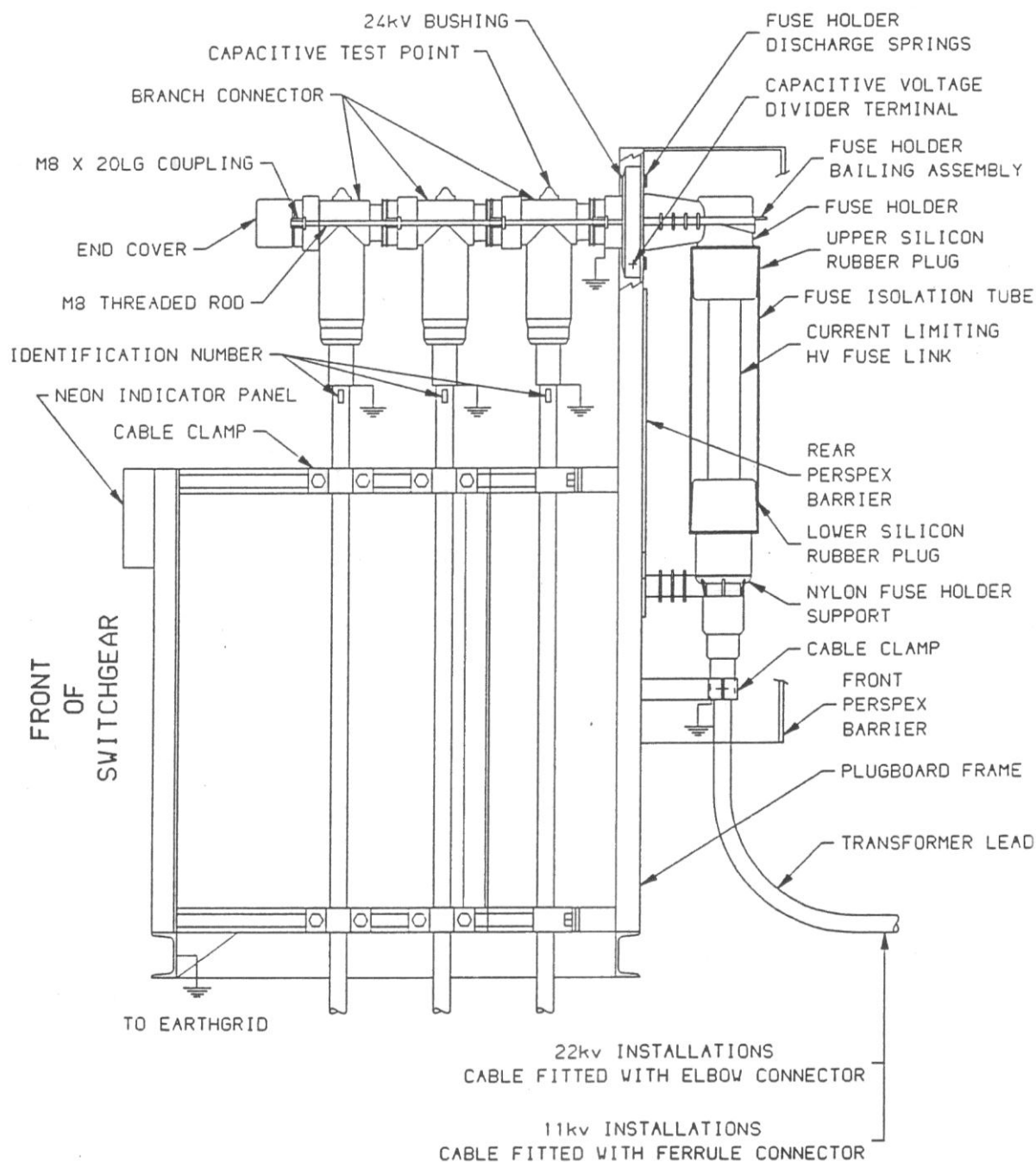


Figure 2 - Plugboard switchgear component parts

5.5 Cast epoxy resin bushings

The bushings have identical 400A profiles on either end and form the central connection point or busbar for the plugboard.

Cast epoxy resin bushings are available from Endeavour Energy's store. The stock code number is:

SB12099 Bushing HV plugboard

Fuse holder and branch connector bailing assemblies are connected to the M8 ferrules

cast into the bushings.

Two (2) interconnected capacitive divider terminals are provided on each bushing. Only one (1) terminal on each bushing is to be used for connection to the permanently connected neon indicators: the second terminal is to be disregarded.

Neon indicators for permanent connection to the capacitive divider terminals are available from the store. Each neon indicator kit consists of neon indicators, sockets and short circuiting plugs for all three phases. The short circuiting plugs are to be inserted into the sockets to prolong the life of the neons when the substation is not attended.

The stock code number is:

SK10584 Kit neon indicator for plugboard

5.6 Cable terminating branch connectors (elbows)

Branch connectors are fully screened push-fit elbows, suitable for cable diameters ranging from 25mm² to 240mm² by using the appropriate stress control cone. When connected to earth, branch connectors are considered to be *touch safe* due to the silicon rubber outer conductive layer.

Two (2) sizes of branch connectors are available from the store. The stock code numbers are:

SK10495 Kit branch connector 240mm² cable, manufactured by Felten.

SK10576 Kit branch connector 150mm² cable, manufactured by Guillaume (F and G).

Branch connector kits consist of three (3) cable connectors and accessories to terminate one (1) feeder.

Each screened branch connector is electrically bonded through the bailing rods. At the bushing ends, the bailing rods are earthed to the plugboard frame holes adjacent to each bushing, using a 16mm² (minimum size) copper earthing conductor. The cable core screen wires are earthed to the plugboard frame holes adjacent to each connector.

Assembly of the branch connectors is achieved by the use of threaded inserts and long cylindrical connecting bolts, which also form the current path.

Before assembly, use a clean, dry, lint-free cloth to thoroughly clean all interfacing surfaces. Apply an even, thin smear of assembling paste to both surfaces at the bushing to branch connector interface, and to both surfaces of the branch connector to the adjoining branch connector or end cap interface. The assembling paste (yellow in colour) is available from the store.

The stock code number is:

SP12911 Paste to suit F and G plug in connectors

Note: It is essential that only this paste, and no other, be used on the interfacing surfaces of the branch connectors bushing and end caps. The correct application of this paste is vital to *maintain* proper impulse performance of the switchgear.

For detailed branch connector assembly and jointing details, and connecting bolt tensions, refer to Drawing no. 078212.

Feeder cables are to be secured top and bottom to the plugboard frame *Unistrut* channel using a cable clamp available from the store. The stock code number is:

SC11100 Clamp cable for plugboard

Each feeder cable is to be fitted with a cable marker indicating the phase and the switch identification number.

Cable markers, in accordance with Region Project Drawings, will be provided with each plugboard supplied by the Hoxton Park Transformer Workshop.

Cable markers are to be fitted on site, directly below the branch connector and above the upper cable support clamp on each cable.

5.7 Fuse assembly

The fuse assembly is a non-screened plug-in system and is not to be considered as *touch safe*. To prevent accidental touching by personnel, the HV fuse assembly will be fitted with a *Perspex* barrier with a warning label, and the HV cubicle end doors will be fitted with an internal latch bolt in lieu of an external key lock. Fuse assembly kits and the *Perspex* barriers are available from the store.

The stock code numbers are:

SB12080 Barrier for plugboard fuse assembly

SK10401 Kit fuse assembly plugboard 11kV, manufactured by F and G

SK10428 Kit fuse assembly plugboard 22kV, manufactured by F and G

The 11kV fuse assembly kit contains adaption tubes to allow installation of the shorter 11kV fuse links. If a substation is uprated from 11kV to 22kV, the adaption tube is to be removed and the 11kV transformer leads are to be replaced with 22kV transformer leads.

The adaption tube and the 11kV transformer leads are to be returned to the Hoxton Park workshop.

Transformer leads for 11kV to 22kV uprates are available from the store. The stock code number is:

SK10363 Kit fuse assembly conversion

Important: The 11kV fuse assembly is suitable for all diameters of 11kV fuse links; however, the 22kV fuse assembly is suitable only for 22kV fuse links with diameters of 65mm.

Before assembly, use a clean, dry, lint-free cloth to thoroughly clean all interfacing surfaces. Apply an even, thin smear of assembling paste to both surfaces at the bushing to fuse holder interface, and to both surfaces at the lower silicone rubber plug to fuse isolation tube interface. This will allow the installation and removal of the fuse holder and the fuse isolation tube during fuse replacement and transformer isolation, and deliver proper impulse performance of the switchgear. This assembling paste (yellow in colour) is available from the store.

The stock code number is:

SP12911 Paste to suit F and G plug in connectors

Note: It is essential that only this paste, and no other, be used on the interfacing surfaces of the fuse assembly. The correct application of this paste is vital to maintain proper impulse performance of the switchgear.

The transformer connection is to be made in accordance with section 5.8.

5.8 Transformer connection

The 11kV transformer cables are fitted with ferrules for connection to the 11kV transformer using the cable connection kit available from the store. The stock code number is:

SK10460 Cable termination kit for 11kV transformer

The 22kV transformer leads are fitted with elbow connectors for connection to the 22kV transformer.

Before connecting, use a clean, dry, lint-free cloth to thoroughly clean all interfacing surfaces. Apply an even smear of assembling paste to both surfaces at the transformer bushing to elbow connector interface. The assembling paste (yellow in colour) is available from the store. The stock code number is:

SP12911 Paste to suit F and G plug in connectors

Note: It is essential that this paste and no other be used on the interfacing surfaces of the transformer bushing to elbow connector interface.

Each 22kV transformer cable elbow connector is to be suitably secured to the transformer by using the metal flanges on the elbow connectors. These metal flanges are to be earthed to the transformer earth stud, using 16mm² (minimum size) copper earthing conductor.

The screens on the transformer cables are to be earthed to the plugboard frame holes adjacent to each transformer cable.

5.9 Anti-condensation heaters

Anti-condensation heaters are not required.

5.10 Accessories

5.10.1 Earthing

Operator earthing facilities for distribution substations with plugboard switchgear are provided on the HV and LV side of the transformer. Refer to figure 3 below for HV earthing arrangement.

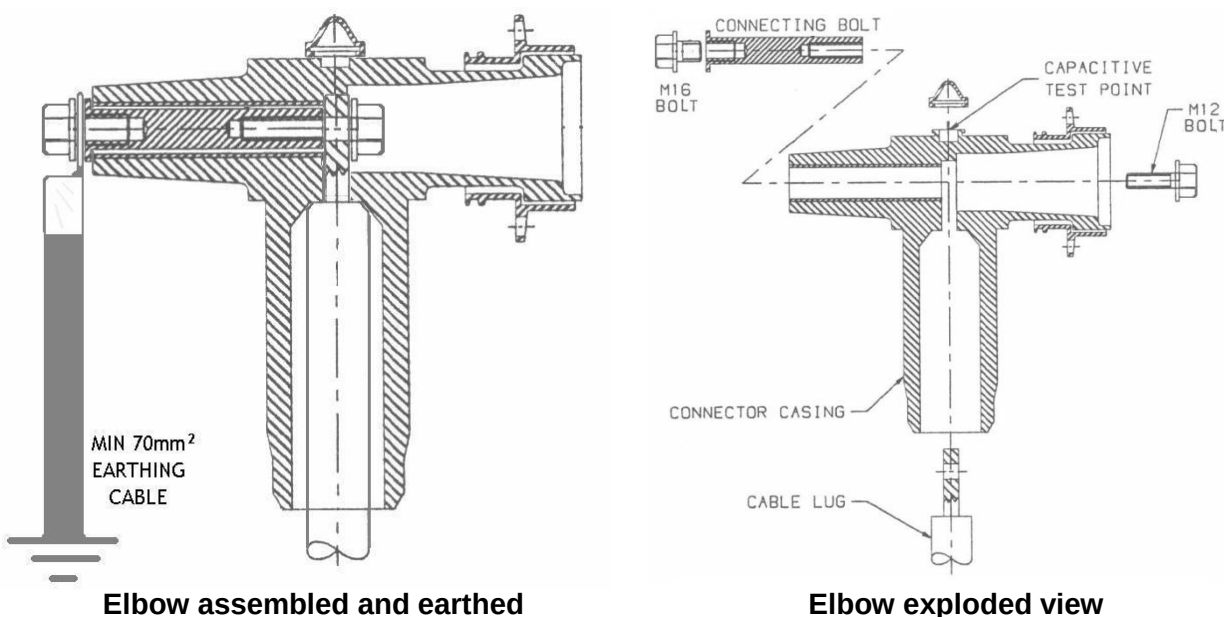


Figure 3 - HV earthing arrangement

The HV earth is required to be installed before the LV earth, as the LV earth may not operate HV feeder protection for accidental HV energisation.

If switchgear specific HV earths are unavailable, a portable HV earth set with the following construction shall be used:

- a flexible 70 mm² Cu (or equivalent Aluminium) insulated (LV insulated) cable
- one end lugged with 18mm hole tinned copper cable lugs
- the alternate end fitted with earth clamps with insulated (LV insulated) handles for clamping on to a 6mm bus bar

An LV earth set is used for the purpose of providing protection from back feed from the LV reticulation system.

Portable LV earth sets used on the LV side shall be fitted with:

- flexible 70 mm² Cu (or equivalent Aluminium) insulated (LV insulated) cable
- one end lugged with 12mm hole tinned copper cable lugs
- the alternate end fitted with earth clamps with insulated (LV insulated) handles for clamping on to a 6mm bus bar

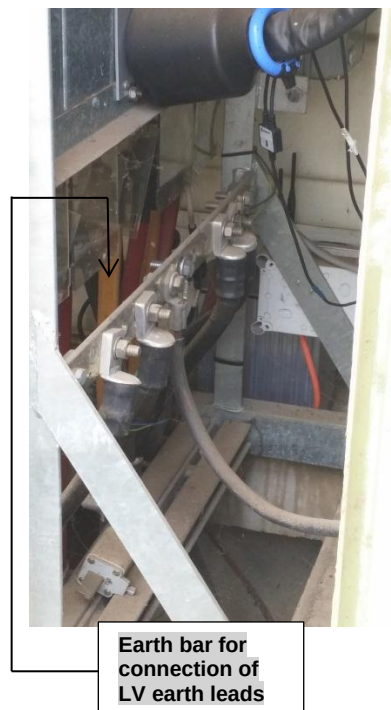
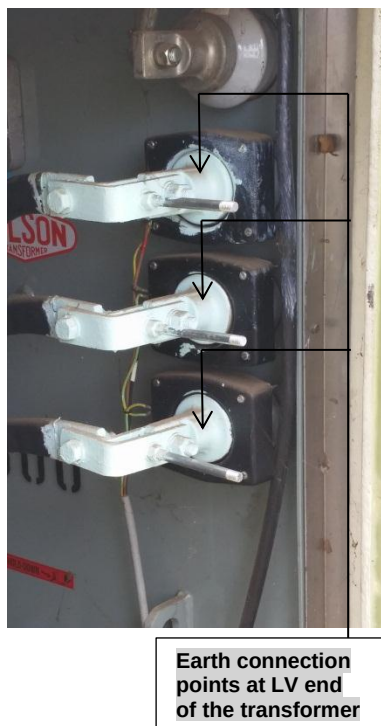


Figure 4 - LV earth connection points

Note: Earthing and switching functions can only be carried out by authorised personnel.

Refer to Network Operations Workplace Instructions for more details.

5.10.2 Short circuit indicators

The short circuit indicators consist of a glass window with a clear display. In the presence of a fault, the magnetic field set up agitates a ball and spring, causing the window to change to red display. This will remain for approximately two (2) hours.

The short circuit indicator clamps around the feeder cable tubes, which are located at strategic points on underground feeders, as directed by Network Operations.

5.11 Operating procedure

5.11.1 General

Prove that the plugboard is de-energised and earthed in accordance with Network Operations Workplace Instructions. Once proved, the feeder branch connectors and/or transformer fuse assembly can be operated by hand, as described below.

5.11.2 Fuse assembly

Remove fuse assembly Perspex barrier. Lift the fixing bracket and slowly pull the upper fuse connection elbow away from the bushing.

Withdraw the upper fuse connection elbow and fuse isolation tube. Once withdrawn, the fuse link can be inserted or changed.

Important: The 11kV fuse assembly is suitable for all diameters of 11kV fuse links. However, the 22kV fuse assembly is suitable only for 22kV fuse links with diameters of 65mm.

When inserting a fuse link, verify that the striker end faces upwards.

If re-assembly is not carried out immediately, the fuse assembly and bushings are to be covered with plastic bags to avoid exposure to contaminants so that they remain as clean as possible. Before re-assembly, use a clean, dry, lint-free cloth to thoroughly clean all interfacing surfaces.

If required, an approved solvent (*Texil Delv-Elec D-31*, vocab no SS17163) may be used sparingly to help this process.

Apply an even, thin smear of assembling paste to both surfaces at the bushing to fuse holder interface, and to both surfaces at the lower silicon rubber plug to fuse isolation tube interface.

This assembling paste (yellow in colour) is available from the store. The stock code number is:

SP12911 Paste to suit F and G plug in connectors

Note: It is essential that only this paste, and no other, be used on the interfacing surfaces of the fuse assembly. The correct application of this paste is vital to maintain proper impulse performance of the switchgear.

Once assembled, the fuse isolation tube should fit tightly between the collars of the upper and lower silicon rubber plug.

Push fuse assembly onto the bushing and fit the fixing bracket. Reinstall fuse assembly Perspex barrier.

5.11.3 Branch connectors (elbows)

Refer to Drawing no. 078212 for assembly details.

After disconnection, if re-assembly is not carried out immediately, the branch connectors and/or end caps and/or exposed bushing are to be covered with plastic bags to avoid exposure to contaminants so that they remain as clean as possible.

Before re-assembly, and in accordance with the abovementioned instruction, use a clean, dry, lint-free cloth to thoroughly clean all interfacing surfaces. If required, an approved solvent (*Texil Delv-Elec D-31* vocab no SS17163) may be used sparingly to help this process.

Apply an even, thin smear of assembling paste to both surfaces at the bushing to branch connector interface and to both surfaces of the branch connector to the adjoining branch connector or end cap interface.

This will help the installation and removal of the branch connectors and end caps during operation, and provide proper impulse performance of the switchgear.

This assembling paste (yellow in colour) is available from the store. The stock code number is:

SP12911 Paste to suit F and G plug in connectors

Note: It is essential that only this paste, and no other, be used on the interfacing surfaces of the branch connectors, bushings and end caps. The correct application of this paste is vital to maintain proper impulse performance of the switchgear.

5.12 Operating single line diagrams

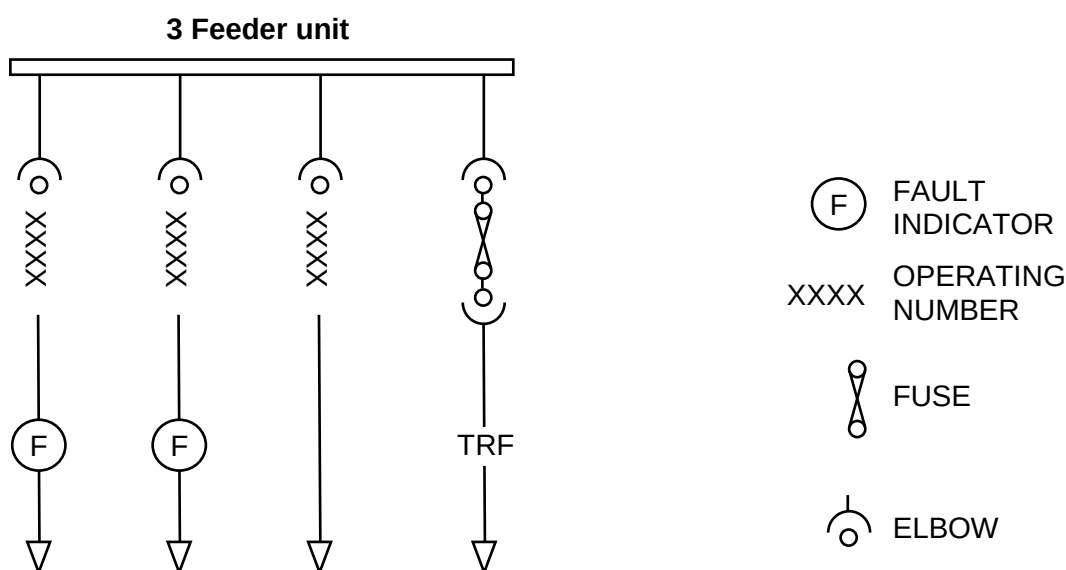


Figure 5 - 3 feeder unit single line diagram

5.13 Drawings

The following drawings form part of this instruction:

Drawing	Am.	Title
077512	C	22kV Plugboard Frame Fabrication Detail
077513	A	22kV Plugboard Frame Assembly
077535	A	22kV Plugboard Brace Detail
078212	C	F and G Elbow to 22kV Plugboard Termination
078292	B	22kV Plugboard Fuse Assembly Barrier Detail

6.0 AUTHORITIES AND RESPONSIBILITIES

General Manager Asset Management has the authority and responsibility for approving this instruction and approving variations to the requirements of this instruction.

Manager Asset Standards & Design has the authority and responsibility for endorsing and recommending changes and revisions to this instruction.

Network Substations Manager has the authority and responsibility for revising and updating this instruction in accordance with Company Policy and Procedures.

Regional Managers have the authority and responsibility for determining that the staff are appropriately trained in installing portable HV and LV earths on plugboard switchgear when required and that all designs carried out by Regional employees conform to the requirements of this instruction.

Manager Network Connections has the authority and responsibility for determining that all designs carried out by Level 3 ASPs conform to the requirements of this instruction.

Accredited Service Providers have the responsibility to determine that the latest issue of any instruction or drawing relevant to or listed in this manual is available and used

during the design of any project.

7.0 DOCUMENT CONTROL

Documentation content coordinator: Network Substations Manager

Documentation process coordinator: Branch Administrator